HIGHLIGHTS

1987

NASA Excellence Award

For Quality and Productivity

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For Quality and Productivity

1987 Recipient

Rockwell International Rocketdyne Division

Sponsored by the
National Aeronautics and Space Administration
Office of Safety, Reliability, Maintainability and Quality Assurance, NASA Quality and Productivity Improvement Programs

with the assistance of the
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February 1989

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INTRODUCTION

The NASA Excellence Award for Quality and Productivity is the result of NASA's desire to encourage superior quality in the aerospace industry. It is awarded to NASA contractors, subcontractors, and suppliers who have demonstrated sustained excellence and outstanding achievements in quality and productivity. The objectives of this award are to:

- increase public awareness of the importance of quality and productivity to the nation's aerospace program and industry in general;
- encourage domestic business to continue efforts to enhance quality, increase productivity, and thereby strengthen competitiveness;
- provide the means for sharing the successful methods and techniques used by the applicants with other American enterprises.

It is clear from the past three years that companies have demonstrated commitment to quality and productivity improvement by the highest level of management and by the entire work force. The aura of success was certainly prevalent at these "finalist" companies and could easily be detected by our on-site validation teams.

We believe this award process, in the beginning of its fourth year, is showing the benefits that can be derived by participating in the program. It is starting to develop a learning environment for those organizations seeking to improve the quality and productivity of their products and services.

This "Highlights" booklet is intended to allow transfer of successful techniques demonstrated by the performance and quality of work accomplished by Rocketdyne—this year's award recipient. The booklet, organized by the seven strategies developed by NASA and its contractor team, details Rocketdyne's efforts in achieving outstanding performance. NASA urges other aerospace companies to emulate and tailor to their needs the successful methods and programs highlighted in this booklet.

Joyce R. Jarrett, Director
NASA Quality and Productivity
Improvement Programs

F O R E W O R D

Quality is vital to the space program and requires a team commitment by NASA and its contractors to build quality and reliability into our products and services. To further these aims, NASA annually presents the NASA Excellence Award for Quality and Productivity to those NASA aerospace companies—both large and small—whose products exemplify the highest standards of performance. The award recognizes organizations that continually seek to improve and demonstrate sustained quality of their products and services.

I wish to thank all the contractors that applied for the Excellence Award and my special congratulations to Rocketdyne—the award recipient for 1987. NASA is committed to working with its contractors to achieve excellence. Those NASA companies who apply for NASA's most prestigious award and go through the rigid examination process show us they are committed to excellence. It is this type of commitment that will enable this country to remain a competitor in the world market. We look forward to greater participation by our contractors in the future as we continually seek to build quality and reliability into the products and services that are so vital to our space program and our country.

George A. Rodney
Associate Administrator for Safety,
Reliability, Maintainability and
Quality Assurance

Rockwell International

At Rockwell, I know that many of the most effective approaches to meeting the challenges of the Space Shuttle program have come from innovative thinking. The NASA Excellence Award for 1987 reflects Rocketdyne's innovative approaches to quality and productivity. This award makes all Rockwell people proud of our contributions to our nation. It also makes us determined to strive for new accomplishments.

In the months and years ahead, NASA and its contractors will grapple with some of the toughest quality challenges we have ever faced. Constantly improving the space transportation system, lowering the cost of boosting heavy payloads to orbit, building the world's largest and most diversely capable space station, and finding ways to improve the efficiency of our atmospheric transportation system are among them. I can think of no other group more capable of tackling them than this NASA-industry team.

NASA's Excellence Award for Quality and Productivity is providing a path to ensure United States leadership in an intensely competitive world market. The award process itself is a rigorous self-examination of a company's performance. Not only does this process point out a company's strengths but also its weaknesses. The manner in which those weaknesses are addressed determines an organization's future success. NASA is to be congratulated for their initiation and administration of this program.

D.R. Beall
Chairman and Chief Executive Officer
Rockwell International Corporation

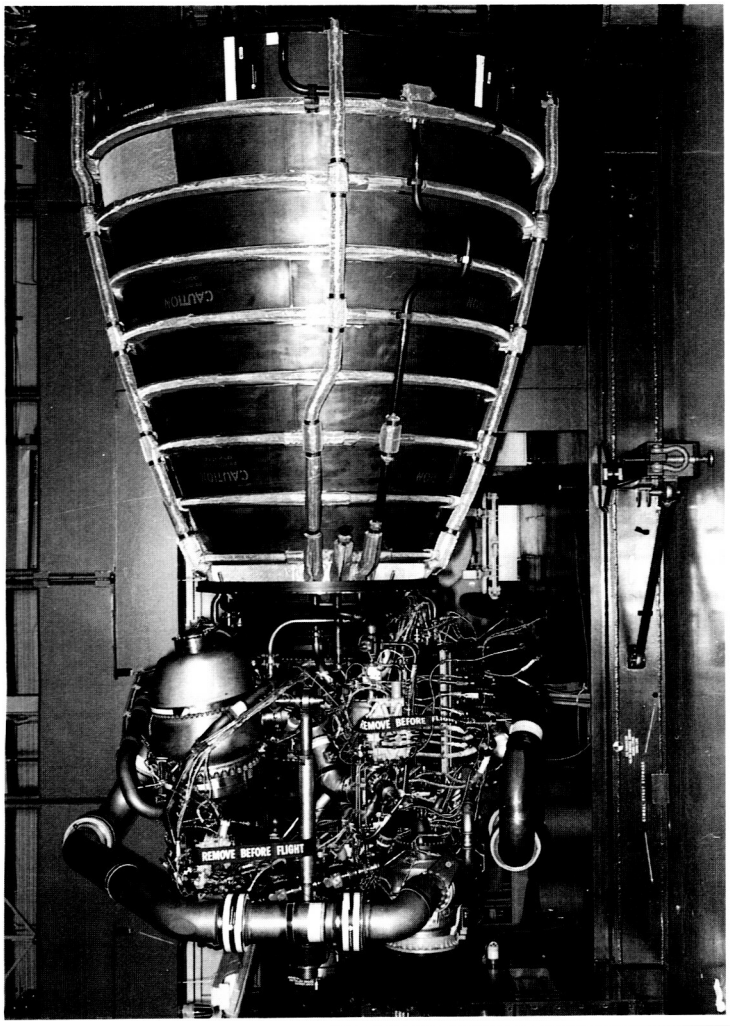

Figure 1.
Space Shuttle Main Engine

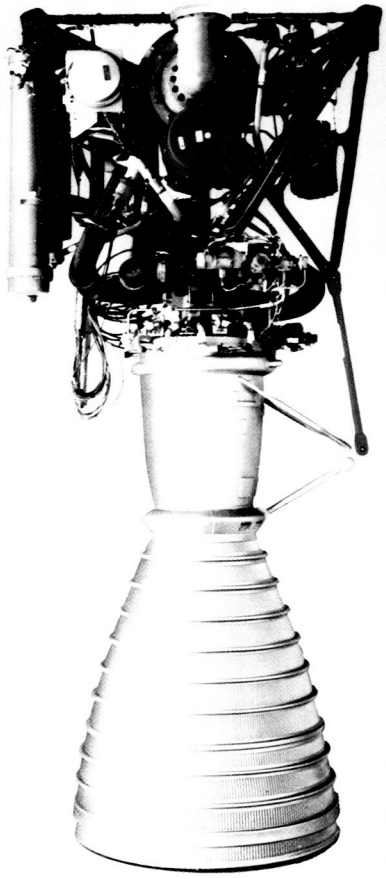

Figure 3.
Delta RS-27 engine system

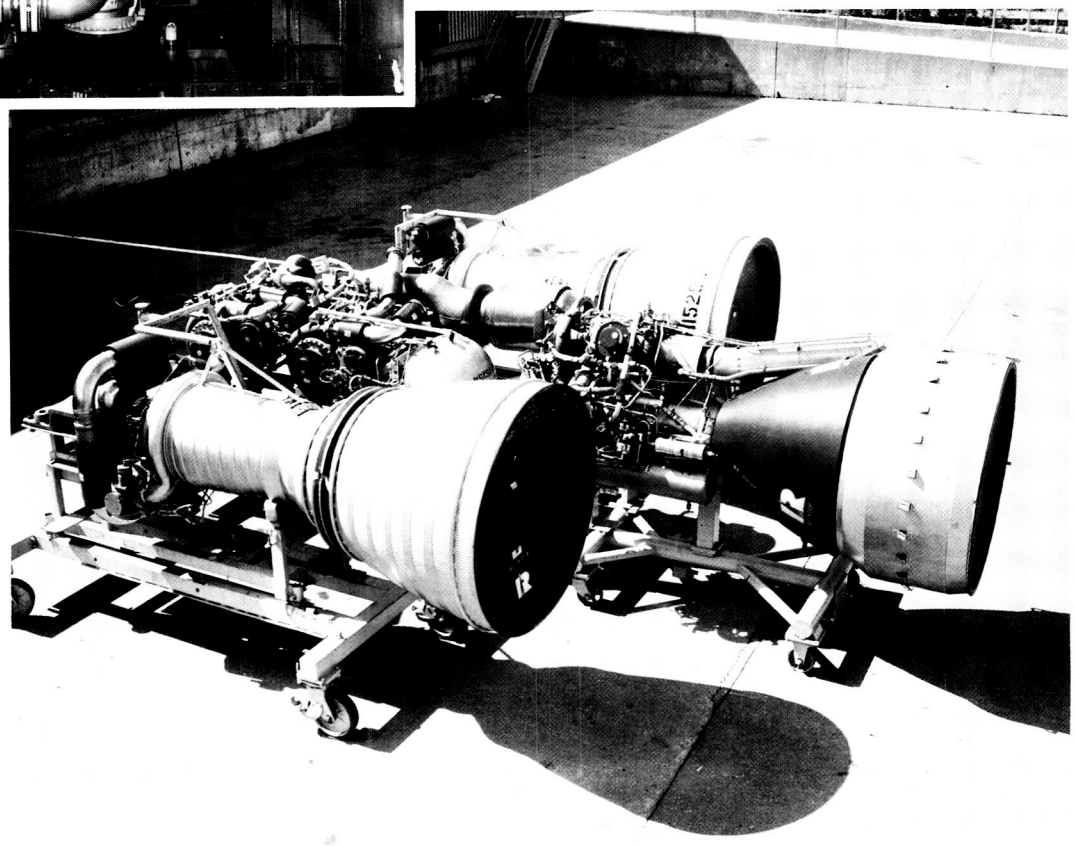

Figure 2.
Atlas MA-5 engine system

Quality.

Rocketdyne is committed to it.

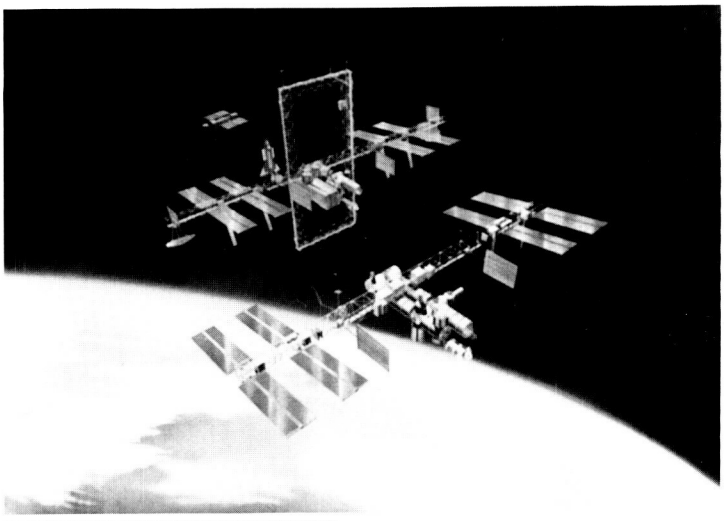

Figure 4.
Space station electrical power system

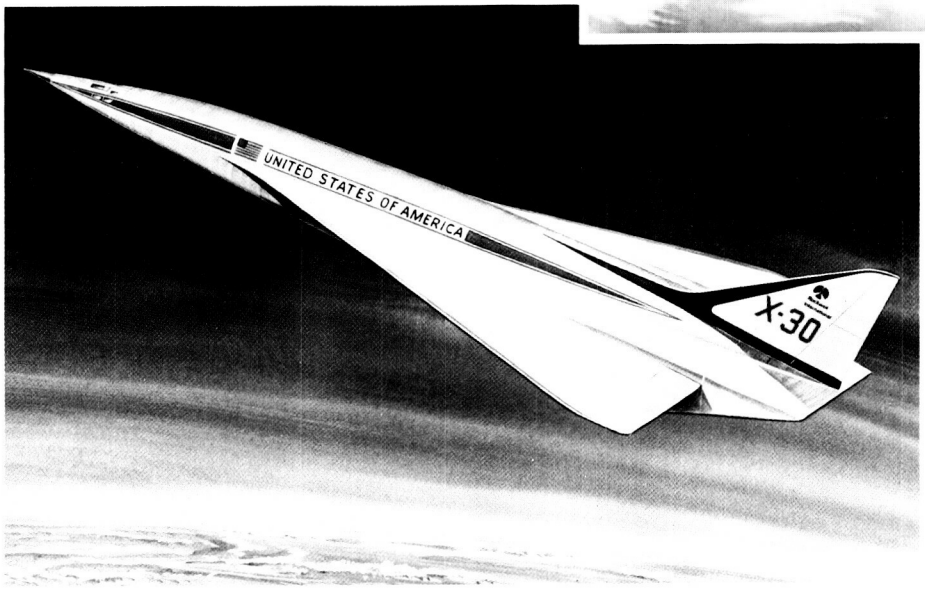

Figure 5.
National Aero-Space Plane propulsion

From the early 1950s and the pioneering development of large liquid-rocket technology, the people of Rocketdyne have taken great pride in the quality of their efforts and, in turn, the results of those efforts. Today, the quality ethic is deeply ingrained in the people of Rocketdyne; it is part of the Rocketdyne culture. Managers, engineers, technicians, and support people are keenly aware of how absolutely critical the launch vehicle propulsion system is to the NASA mission and truly feel a special responsibility for its safety and success.

Rocketdyne's support of NASA-related programs began 40 years ago with the development and production of the Redstone engine which subsequently launched the first U.S. satellite, and which powered the Mercury program and the first American in space. Throughout America's space history, Rocketdyne has designed, developed, and produced for NASA a continuous and highly successful line of rocket engine systems:

- Redstone engine
- Jupiter engine
- Gemini reaction control engine
- F-1 Saturn V first-stage engine
- J-2 Saturn V second- and third-stage engines
- Apollo lunar ascent engine
- Apollo command module Reaction Control System (RCS) thrusters
- H-1 Saturn 1B first-stage engine
- Mars Mariner/Viking engine
- Atlas MA-5 launch vehicle engine
- Delta RS-27 launch vehicle engine
- Space Shuttle Main Engine (SSME)

Rocketdyne's current work with NASA includes the SSME (Figure 1), the Atlas MA-5 (Figure 2), the Delta RS-27 (Figure 3), the Space Station Electrical Power System (Figure 4), and the National Aero-Space Plane propulsion system (Figure 5). In these programs and other efforts, we support Marshall Space Flight Center, Lewis Research Center, Kennedy Space Center, Goddard Space Flight Center, Langley Research Center, Stennis Space Center, and the Jet Propulsion Laboratory.

We are proud to have been a part of the NASA team throughout this history and to be part of the continuing journey into space.

THE ROCKWELL CREDO: WHAT WE BELIEVE

We believe maximizing the satisfaction of our customers is our most important concern as a means of warranting their continued loyalty.

We believe in providing superior value to customers through high-quality, technologically-advanced, fairly-priced products and customer service, designed to meet customer needs better than all alternatives.

We believe Rockwell people are our most important assets, making the critical difference in how well Rockwell performs; and, through their work and effort, separating Rockwell from all competitors.

We believe we have an obligation for the well-being of the communities in which we live and work.

We believe excellence is the standard for all we do, achieved by encouraging and nourishing:

- Respect for the individual
- Honest, open communication
- Individual development and satisfaction
- A sense of ownership and responsibility for Rockwell's success
- Participation, cooperation and teamwork
- Creativity, innovation and initiative
- Prudent risk-taking
- Recognition and rewards for achievement

We believe success is realized by:

- Achieving leadership in the markets we serve
- Focusing our resources and energy on global markets where our technology, knowledge, capabilities and understanding of customers combine to provide the opportunity for leadership
- Maintaining the highest standards of ethics and integrity in every action we take, in everything we do.

We believe the ultimate measure of our success is the ability to provide a superior value to our shareholders by balancing near-term and long-term objectives to achieve both a competitive return on investment and a consistent increase in market value.

Figure 6. *The Rockwell Credo: What We Believe*

Management Commitment, Leadership

Direction and policy for productivity improvement were established in January of 1976 by Rockwell International's chief executive officer, Robert Anderson. Formalization of the commitment took place in 1982 and 1983 with the drawing up of charters and policy statements for an Executive Productivity Council, an Operating Productivity Committee, and a Director of Productivity.

A Commitment to Excellence initiative on the part of Rocketdyne's president, Richard Schwartz, in January of 1984 called for all managers to seek 100 percent in quality and productivity. In an all-management speech launching the program, Mr. Schwartz expressed the keynote: "We build a very complex product that allows no margin for error. As part of our commitment to the excellence of our products, we need to solve problems before they happen."

In May of 1985 Mr. Schwartz personally launched the Quality Enhancement Plan (QEP). This comprehensive plan required new commitment and, perhaps even more important, a demonstration of the effectiveness of that commitment from line management. To ensure success the Operations Audit function of Rocketdyne was refined and expanded. In addition to an audit being established in each of the five company functions, the plan resulted in establishment of a Division Audit Team reporting directly to the president.

Top management's commitment was highlighted with the formation of the Product Integrity Council in November of 1987. This joint endeavor with the NASA resident manager, the Air Force procurement commander, and Rocketdyne's president and vice presidents includes a bimonthly meeting to review all aspects of quality and productivity through the use of management indicators and trends, and to apply management action. The vice presidents for Engineering, Manufacturing, and Quality Assurance meet weekly with the vice president and Space Shuttle Main Engine (SSME) program managers to explore, select, and implement designs that will make the SSME more producible.

Rocketdyne's quality commitment is also demonstrated by top management's allocation of company capital to modernize facilities and equipment. Complementing NASA modernization funds of $18.8 million, Rocketdyne invested $70 million during 1984, 1985, and 1986 for modernization projects that would result in improved productivity and quality. In addition, a major automation effort has been aggressively carried on by management.

Management has actively supported Productivity Improvement and Quality Enhancement (PIQE) with a strong commitment in human resources. A large share of management development was devoted to QEP, Commitment to Excellence, and many other initiatives. From 1984 through 1987, training was increased by more than 100 percent and the number of training instructors by 200 percent. Time was also committed to action circles and PIQE teams because of the positive effects of these employee-involvement activities. Employees as well as managers were assigned to leadership tasks such as administering the Challenge of Excellence program in manufacturing.

As part of our commitment to excellence of our products, we need to solve problems before they happen.

In fact, implementation of the Challenge of Excellence program is simply another example of Rocketdyne's commitment to quality. Manufacturing Operations instituted this motivational program in 1985 to recognize shop-department team members for their performance against specific goals. Objectives are accomplished by graphically depicting monthly departmental performance ratings against goals that are established by the work group for seven categories: quality, performance achievement rating, cost improvement, safety, attendance, schedule, and housekeeping. Posters display each department's monthly, quarterly, and annual scores (Figure 7). Monthly winners are honored in a meeting with upper management, while quarterly winners receive gift certificates and plaques honoring their productivity achievements.

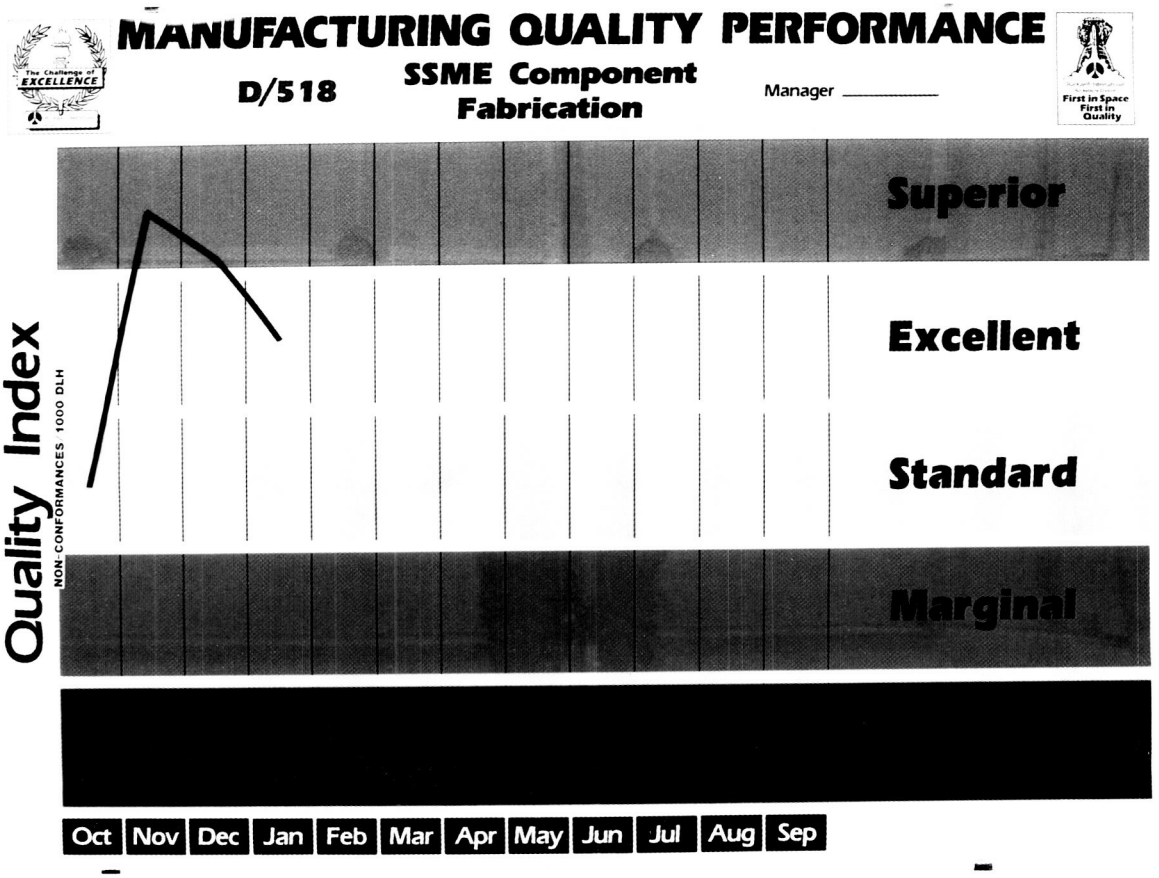

Figure 7. Challenge of Excellence display (1)

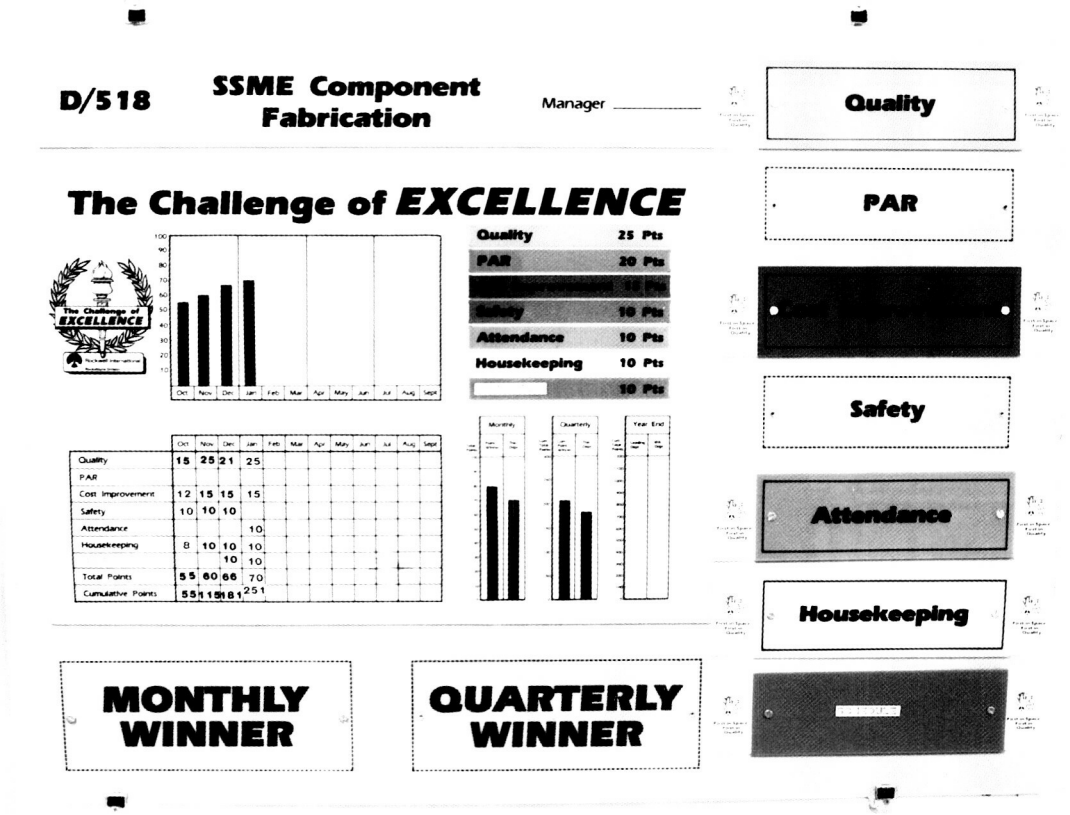

Figure 7. Challenge of Excellence display (2)

Goals and Progress Measurement

Overall PIQE goals are established for the division as part of the Strategic Business Plan and Annual Operating Plan and are signed by the corporate group and Rocketdyne presidents. These goals are assigned to functions and programs reporting to the president and signed by the president and vice president for the function or program. Functions or programs then redefine these goals for signature by those directly reporting to them.

Progress against the goals is monitored by weekly and monthly reports and by a quarterly top-management publication. Here monthly values are plotted for 44 PIQE elements against current goals and achievements of the past two years. Corrective action plans must be included for elements not within the announced goal. PIQE goals are disseminated to all employees by a letter from the president as well as through regular functional channels. Functional management carries responsibility for PIQE and is the prime channel for information.

We feel it is absolutely necessary that employees know immediately if their work is satisfactory. Filling this need also provides positive reinforcement for success in meeting goals and provides a focus on priorities.

Focusing on Customer Needs

The Space Shuttle Main Engine program is dynamic and requires clear communication of performance requirements. Following the loss of *Challenger,* the program focused on a rigorous risk-management system to ensure a safe return to flight.

A multifunctional SSME design-reassessment/margin-improvement board convened with executive management support to define the requirements for a return to safe flight. Strong internal and NASA communication links were maintained between all levels of functions to ensure the prompt identification and resolution of issues. Thirty-nine improvements were identified and incorporated in the program; 21 of these required hardware changes and were certified in the most aggressive ground-test program in the history of the SSME. Special emphasis was placed on the test program, and major reviews were undertaken to rebaseline the SSME:

- A 12-volume, 4,000-page in-depth Failure Mode and Effects Analysis (FMEA) and the associated Critical Items List (CIL) were generated and presented to NASA.
- More than 900 CIL items were reviewed for management risk assessment and hazards analysis.
- More than 7,000 pages of launch operations and maintenance procedures for all Shuttle processing documents were reviewed at Kennedy Space Center.
- All launch-commit criteria, SSME redlines, and software logic were reviewed.
- Twelve volumes and more than 4,000 pages resulted from the design requirement and certification review.
- A 20,000-page report was completed assessing the design, fabrication, inspection, and operational history of more than 3,000 SSME critical welds in support of the FMEA/CIL.
- Approximately 5,000 pages resulted from a structural audit on 130 SSME critical components. The audit was a comprehensive review of all analysis, hardware, testing, and supporting data, with emphasis on the long-term operational capability of the SSME.
- More than 20,000 destructive and nondestructive inspections were performed and analyzed on two high-time SSMEs.

Communication between Rocketdyne/Canoga Park, the field sites, and NASA is essential to improve performance and meet new levels of customer expectations for a vigorous SSME ground-test program and safe return to flight. Daily, weekly, monthly, and quarterly teleconferences and meetings are used to inform all personnel of program requirements. All SSME ground-test readiness reviews are linked by teleconferences between Rocketdyne/Canoga Park, the test site, and Marshall Space Flight Center to ensure that test objectives and issues are precisely understood. Daily field-site teleconferences among Stennis Space Center, Kennedy Space Center, the Huntsville Simulation Laboratory, and Canoga Park are held to determine the status of activities and to set daily performance objectives. We also respond to reviews outside the regularly scheduled program meetings. In support of the return to flight, 114 reviews were presented to Marshall Space Flight Center, Stennis and Kennedy Space Centers, NASA headquarters, the Aerospace Safety Advisory Panel, the National Research Council, Congressional staff, and the Office of the Management and Budget in 1987.

The Space Shuttle Main Engine program focused on a rigorous risk-management system to ensure a safe return to flight.

The major part of our ground-test program consists of development, certification, life-extension, and margin testing. The ground-test program is integral to SSME risk management; risk management is performed on the ground, not in flight. Of the 118 tests performed in calendar year 1987, only two development tests, and two life-extension tests resulted in an early engine shutdown caused by an operating anomaly. None of these early shutdowns was caused by a criticality I condition. This significant reduction in premature shutdowns (Table 1) is a result of improved quality, which provides high SSME reliability.

Table 1. SSME unsatisfactory condition reports

Calendar Year	Number of Tests	Number of Premature Shutdowns	Percentage Shutdowns
1982	127	13	10.2
1983	96	6	6.2
1984	77	7	9.0
1985	74	5	6.7
1986	34	3	8.8
1987	118	4	3.3

The SSME ground-test program made 1987 and 1988 pivotal years in support of a September 1988 launch date. During that time, we responded to a request from the director of the Marshall Space Flight Center to perform an accelerated limits/margin test program as part of the total SSME risk management program. The equivalent of 58 Space Shuttle flights (or 91,060 seconds) was conducted at the Stennis Space Center and Santa Susana Field Laboratory (SSFL) since June of 1986. (The number of equivalent flights equals the total test seconds divided by 1,560 seconds, the nominal flight duration of three SSMEs.) The important achievements of the Rocketdyne/NASA team are listed below:

All SSME ground-test readiness reviews are linked by teleconferences to ensure that test objectives and issues are precisely understood.

- More than 361,000 seconds (the equivalent of 231 Space Shuttle launches) have been tested on the SSME since the beginning of the program.
- The 55-start and 7.5-hour design life was demonstrated on all engine components with the exception of the high pressure oxidizer turbopump, fuel turbopumps, and low pressure oxidizer turbopump.
- A single build of a low pressure fuel pump was tested 60 times for 27,912 seconds without disassembly. This is the first time design life has been demonstrated on an element of turbomachinery.
- Sixty limit, malfunction simulation, and margin tests have been performed since June of 1986.
- Six tests were conducted in 11 days, setting an all time record.
- Fourteen tests were run in a one-month period (four times).
- Multiple extended duration tests were performed, including two 2,017-second (33.6 min.) tests.
- Fifty-two tests in a 12-month period equalled or exceeded the nominal Shuttle flight duration of 500 seconds.

Several productivity enhancements were implemented on the SSME program to meet accelerated hardware fabrication, test, and flight schedules. Examples of these productivity improvements are listed below:

- Multifunctional teams are extensively used to ensure delivery of quality hardware to support the test and flight schedules. Three engines were assembled and delivered in a one-month period, something never before achieved.
- Electronic mail systems are used to expedite customer approvals. Engineering documents are incorporated into the automated data management system with electronic sign-off and automatic routing.
- An automated test data reduction program has reduced processing time by 33 percent while increasing the quality of the data reviews.
- A Rocketdyne/Kennedy Space Center data network was established to provide real-time SSME engine-data transmittal between Kennedy Space Center and Canoga Park for real-time troubleshooting support, as well as for future postflight support and data analysis. This will significantly reduce the time for ground operations.
- The SSME maintenance facility at Kennedy Space Center was upgraded to accommodate increased off-line activity and strengthen work performance. Even with additional requirements resulting from post-51L rebaselining activities, SSME turnaround time will be reduced by seven days.

Examples of schedule achievements employing multifunctional product teams include delivery of four SSME flight powerheads ahead of schedule, an SSME final assembly record of 28 days, and the assembly of three SSMEs within a 30-day period.

The ultimate in customer satisfaction is outstanding product performance, which is measured by our flight record (Table 2). There have been 26 Space Shuttle flights (or 78 engine launches, at three SSMEs per orbiter). A

Table 2. Rocketdyne flight engine summary (since 1982)

Program	Number of Engines Flown	Number of Successes	Successful (%)
SSME	75	74[a]	98.6
Peacekeeper	20	20	100
RS-27	23	23	100
MA-3	33	33	100
MA-5	28	28	100
Total	179	178	99.4

[a]Mission was successful. Safe shutdown caused by failure of temperature sensor.

Table 3. SSME flight summary

Year	Number of Launches	Number of FRFs	Number of Orbiters
1981	2	1	1
1982	3	2	2
1983	4	1	2
1984	5	1	2
1985	9	1	3

Table 4. Employee involvement in PIQE

Program	Number of Ideas Submitted (1987)
Suggestion awards	3,207
Do It Now	745
Patent disclosures	83
PIQE teams	50
Total	4,085

total of 15 different engines have flown, demonstrating SSME reusability. One engine has flown 10 times, while 10 other engines have flown between five and nine times. In 1985 we had 12 engines available at Kennedy Space Center to support nine launches and one flight readiness firing involving three orbiters, the most in any one-year period (Table 3).

The need for maintenance between flights continued to decrease in the flight program, indicating the effectiveness of our PIQE program. Operational maturity data that measure several key areas affecting flight turnaround are recorded for every launch. The number of checkout anomalies experienced at Kennedy Space Center in 12 later flights was 50 percent lower than in the previous 12 flights. In the same period, the number of in-flight anomalies requiring postflight effort was also reduced by 50 percent. The number of engine modification kits that required installation prior to flight decreased by a factor of 10 during the last 12 flights. Hardware items requiring minor deviation from specification requirements fell 45 percent to only 0.6 items per flight, also reflecting the trend toward quality improvement.

The ground-test program also experienced similar reductions: 44 percent in the number of checkout anomalies and 57 percent in hot-fire anomalies in the past three years (1985-1987) versus the previous three years (1982-1984).

The culmination of 2-1/2 years of SSME rebaselining, ground testing, margin improvement, and enhanced quality contributed to NASA's return to safe flight of the Space Shuttle. This was achieved by focusing on NASA's needs and by working with them as partners throughout the entire decision-making and rebuilding process.

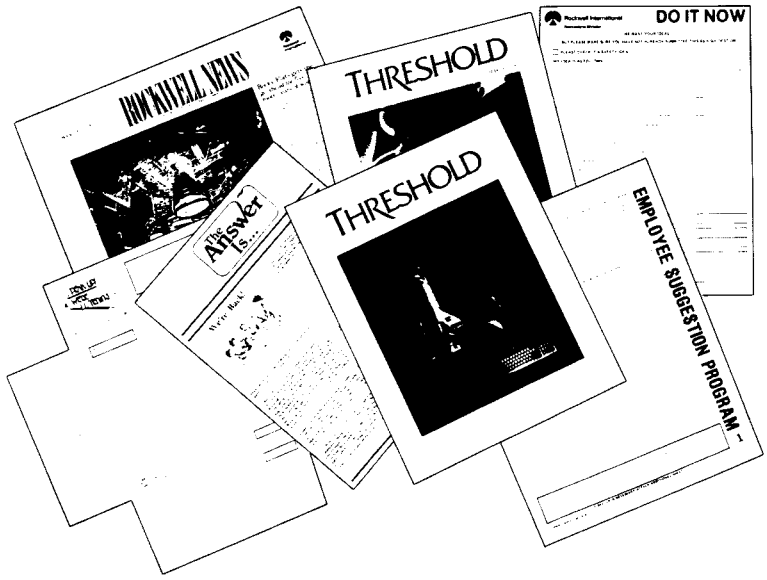

Figure 8.
Printed communications

Open Communications

At Rocketdyne open communication thrives in a network of division-wide programs. In the *Focus on Rocketdyne* video program, selected issues are discussed in an entertaining way; each *Focus* edition is made available four times a year to all employees. This innovative program started in 1987 as a vehicle to communicate productivity and new business plans quickly and effectively.

Rocketdyne president Richard Schwartz meets weekly with 25 managers representing all functional departments. Managers are encouraged to solicit discussion topics from their employees before meeting with Mr. Schwartz. In addition to this program, each executive staff member is committed to holding a comprehensive summary briefing with all of his employees annually.

Our Speak Up, We're Listening program provides direct, executive attention and an answer to the individual at home.

We continue to support and encourage two proven employee communication programs: the Equal Opportunity Advisory Committee (EOAC) and the Management Communicator program. Members of these groups meet quarterly to discuss organizational issues. Function representatives are key to the EOAC, which discusses employee ideas with executive management. Similarly, selected managers attend quarterly Management Communicator meetings as representatives of the work force. They act as a cross-functional team to receive and carry information on company initiatives back to their work areas for discussion with all employees.

To further maintain open communication, we support a variety of print-media programs (Figure 8). The Rocketdyne edition of the *Rockwell News,* a biweekly newspaper distributed to all employees, covers human interest stories as well as informative business-related topics. There are also departmental newsletters and an information telephone line that employees can call to hear fast-breaking company news. And with electronic message boards, we quickly provide information on current events to employees.

Our Speak Up, We're Listening program provides a direct, protected-identity channel from any employee to the president. Since the start date of February 1988, a variety of issues have been covered, with each receiving executive attention and an answer to the individual at home.

During 1987 Rocketdyne conducted a division-wide employee-climate survey to ascertain the major issues affecting organizational health. The purpose was to identify, assess, and analyze roadblocks to increased productivity and to increase employee and manager participation in removing them. The climate survey was divided into three parts: management practices, organizational climate, and special topics. As a result of the survey, we developed a clearer understanding of the problem areas and focused attention on removing the impediments to increased productivity. Individual and group meetings are being held to discuss, recommend, and implement solutions. Members of the executive staff lead small multifunctional teams to coordinate and assess action plans that would have division-wide impact. This survey has established a baseline for measuring our progress.

People Make It All Happen: Education, Training, and Recognition

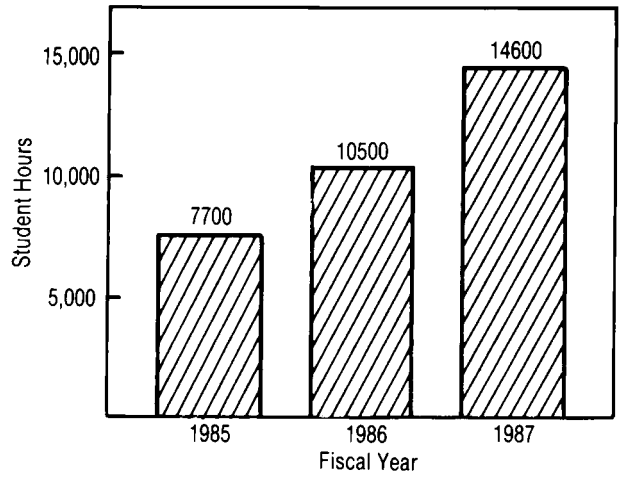

Figure 9. Skill training hours for Manufacturing and Quality

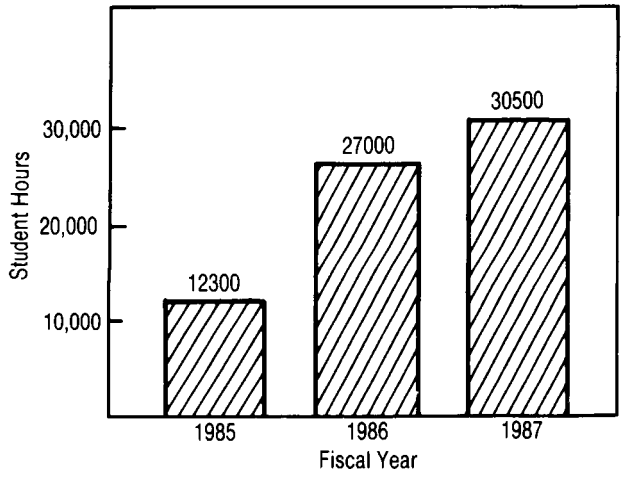

Figure 10. Management training hours

At Rocketdyne we believe we get superior employee performance because of our continuing efforts to educate, train, and recognize employees at all levels. We target four main areas for developing employee performance: technical job skills, management training and development, team and organizational development, and personal development and career counseling. Rocketdyne has invested more than 75,000 hours in company-sponsored training on-site.

Manufacturing and Quality Assurance student hours have increased by 148 percent over three years covering 138 skills. A Training Records System has been developed and now allows significant advance notification to management of course needs and availability (Figure 9).

In 1982 we committed ourselves to strengthening our management and personal development activities. Since then we have increased our organizational-development-professional staff by 200 percent and invested in development studies to determine what was needed for our expanding work force. New classes have been designed and offered to 710 managers on such topics as interpersonal skills, performance appraisals, group dynamics, and team building. A major new thrust has been the development of presupervisory courses for high-potential employees. Additionally, each manager is required to take at least one class each year of a tiered curriculum of management classes. Our top-down approach to management development involves executives, directors, managers, and nonmanagers in learning activities designed to make the company a more productive and better place to work (Figure 10). Two new courses were added this year: Ethics and Standards of Business Conduct (required for all personnel) and Substance Abuse.

Members of our many horizontal teams and employee-involvement teams receive regular training in team-building and problem-solving methodologies. We emphasize PIQE training to multiply the results of our team efforts. The success of our employee development efforts is seen by the quality of the team recommendations.

Employee training and development starts during the first month of employment at the new-employee orientation sessions, which cover such topics as company goals, business plans, PIQE goals, and employee services.

To further improve the potential of employees for greater work responsibilities, Rocketdyne conducts classes in PIQE techniques such as statistical process

control and flow charting. Regular PIQE team training also emphasizes productivity improvement techniques.

We also encourage employees to seek educational reimbursement opportunities at local colleges and universities; the company pays 100 percent of allowable expenses. Artificial intelligence, computer science, mechanical engineering, and business management were areas of keen interest among the 430 employees seeking further education last year.

Personal and career development activities were enhanced last year with the development of our Learning Resource Center. Employees can now borrow instructional aids, video tapes, audio tapes, management texts, and periodicals. Computers are available for self-paced learning. The National Management Association is very active in offering after-hours and lunchtime courses in a number of educational areas. Company instructors taught more than 360 employees in these classes last year. Career counseling is provided by our Educational Programs office to ensure that developmental activities match individual needs and aspirations.

Work-group recognition accounted for 20 PIQE teams receiving certificates of appreciation in 1987. In addition to the $341,000 received by the 1,500 suggestion-award winners last year, additional employee awards were given:

- 132 employees received $100 each for Technology Utilization awards.
- 400 departmental awards, worth a total of $85,000, were given to employees contributing to functional PIQE goals.

A major new thrust has been the development of presupervisory courses for high-potential employees.

- President Schwartz honored 12 employees with the prestigious President's Achievement Award in 1987.

Total employee recognition involved 2,044 employees, or 30 percent of the work force.

In addition to the monetary awards, Rocketdyne awards many employees and managers with certificates and plaques honoring their contributions:

- Manned Flight Awareness awards, represented by the Silver Snoopy Award, were given to 39 employees last year by astronauts.
- A new award was implemented this year to reward employees in our Perfect Attendance program. Hourly employees reaching predetermined levels of perfect attendance receive plaques and merchandise honoring their achievement.
- Rocketdyne recognizes technical excellence with the annual Engineer-of-the-Year awards. This corporate event honors engineers who have demonstrated excellence in their field.
- Many recognition events take place spontaneously as functional groups reward employee innovation and enthusiasm with company-sponsored social events after hours.

Each departmental and functional area of the company has the authority to recognize employees using the division recognition system. The dollar amount of these awards is proportional to the degree of achievement. By far the largest number of recognitions are unscheduled, given simply when management believes it appropriate to honor an employee for special performance.

Rocketdyne Division

ROCKWELL NEWS

Rockwell International

PIQE: a way to get more involved in making Rocketdyne better

Figure 11. Engine final assembly PIQE team

Teamwork, Involvement, and Dedication

Our PIQE teams (Figure 11) are based on the beliefs that it is natural for people to want to achieve organizational objectives, that eliminating barriers to work effectiveness is motivating, and that those closest to the work hold a vast reservoir of insight for achieving organizational improvements.

The evolution of employee involvement that became the PIQE teams resulted in several changes: an integrated support structure consisting of an Executive Steering Committee and several Functional/Program Steering Committees; an established budget to support meetings and training; an extensive training schedule for Functional/Program Steering Committees, team leaders, and members; project measurement/tracking responsibilities resulting in an annual report; and a formal recognition/reward program for teams implementing projects.

Our PIQE team organization covers a range of team structures designed to meet the needs of the issues to be resolved. Some examples are internal consulting teams working systemic issues and reporting directly to the president; intact work groups, made up of a manager at any level and his/her direct reports, to work interdepartmental/functional issues; and horizontal teams to work issues and opportunities that cross departmental/functional boundaries.

Horizontal cross-functional teams have been part of Rocketdyne's culture for decades. A particularly noteworthy recent example is the SSME powerhead team formed in February of 1987, which succeeded in fabricating a schedule-critical powerhead in a fraction of the normal lead time. This team evolved into a permanent, chartered multifunction team with Engineering, Manufacturing, Quality Assurance, Purchasing and Program Office specialists. Since then, eight other major product multifunction teams have been formed under the same charter to improve quality, cost, and schedule on the entire SSME. The charter establishes an executive overview and the details of authority and accountability. During 1987 there were 197 teams operating with 722 members. Since 1982 more than 200 team projects have been implemented. One such project team, known as Engine Line Eagles, reduced nonconformances in the final assembly area by 33 percent, saving the government $168,000 and netting the team the Region IX Outstanding Circle Award from the International Association of Quality Circles.

During 1987 there were 197 teams operating with 722 members.

An early and still very successful cornerstone of Rocketdyne's PIQE program is the Suggestion Award Program, which itself has won national awards for performance excellence. Not only does the company benefit, but employees receive monetary awards for their efforts. The $341,000 paid to employees in 1987 was 21 percent over the 1986 total. The $5.6 million in savings realized in 1987 was a record, topping the previous high by $200,000. Our high acceptance rate of 48 percent for suggestion ideas is above the industry average and represents more than 1,500 accepted ideas out of a submitted volume of 3,200 suggestions (Table 4).

The Do-It-Now Program, in operation for four years, gives employees a quick way to offer ideas to management without going through the Suggestion Plan. Any idea can be submitted regardless of perceived value to the company. There were 745 ideas submitted last year. Individuals whose ideas are selected are presented a plaque as recognition.

A Quality Ethic

To obtain quality, we at Rocketdyne continually strive to improve hardware conformance to requirements and product performance by setting increasingly high standards and by exercising discipline in design, workmanship, and process control. Quality improvements then automatically enhance productivity by reducing costs for scrap, rework, and repair, and for planning and implementing recovery actions.

Quality reporting that is responsive, open, and objective and provides accurate, clear, and timely information is a key element in our quality program. Our monthly Quality Performance Report compiles quality data analyses, and trends are reported by function and program. This report communicates trends requiring corrective action to management, program offices, and our customers. Because welding is a frequent and critical part of our products, a unique weld-performance system has been developed. This computer-based system permits weld defects and their points of occurrence to be analyzed comprehensively and provides statistics on the performance of individual welders. Data analysis also permits us to make educated adjustments of weld parameters to increase weld process yield.

Quality reporting that is responsive, open, and objective and provides accurate, clear, and timely information is a key element in our quality program.

We also support customer-initiated quality communication and reporting programs through active participation in customers' weekly or monthly action item and corrective action status meetings. Working side-by-side with our customers, we develop quality performance criteria and goals each year.

Planning quality is a key to product integrity. Production planning documentation receives a thorough review before release, assuring no planning errors. The direct result has been a continued reduction of our low nonconformance rate, already only one-third the industry average.

During the past two years we reduced our nonconformance rate by more than 35 percent, even though we have developed more discriminating inspection techniques, increased inspection training, and added state-of-the-art equipment (Figure 12). In our assembly areas we continue to improve our inspection ability, and yet nonconformances per 1,000 direct labor hours have been reduced by 80 percent over the past four years (Figure 13).

Scrap, rework, and repair costs are less than the aerospace industry average and have been decreased by 25 percent over the past two years (Figure 14). The Material Review Board activities have been reduced by 32 percent over the past two years. Our current rate of 1.4 material review boards per 1,000 direct labor hours is less than the industry average and is equivalent to one material review nonconformance every 4.3 months per manufacturing operator (Figure 15). Our repetitive material review rate has been decreased by 36 percent over the past year. It is now three per 10,000 direct manufacturing hours, with a third recurrence less than once every 50,000 direct manufacturing hours (Figure 16).

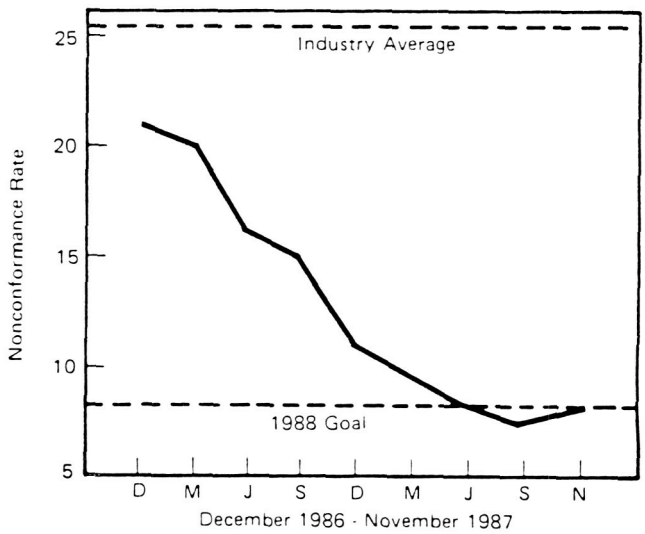

Figure 12. Nonconformances per 1,000 direct labor hours (all programs)

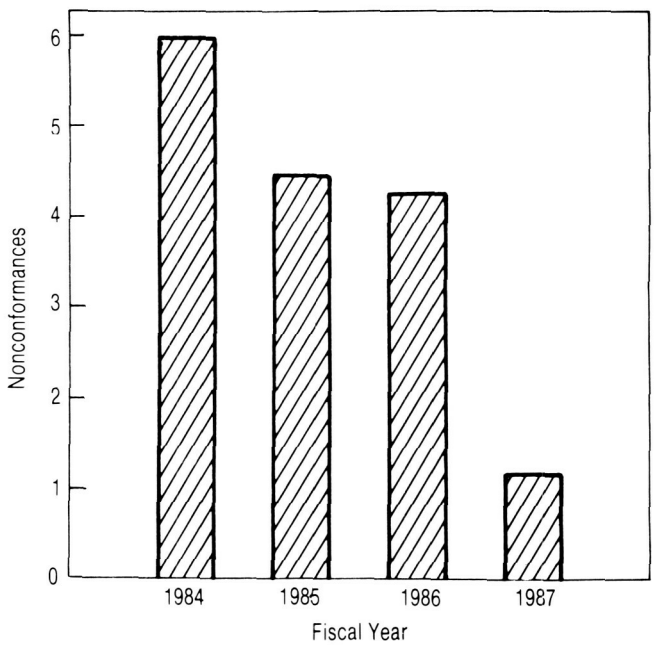

Figure 13. Assembly nonconformances per 1,000 direct labor hours (all programs)

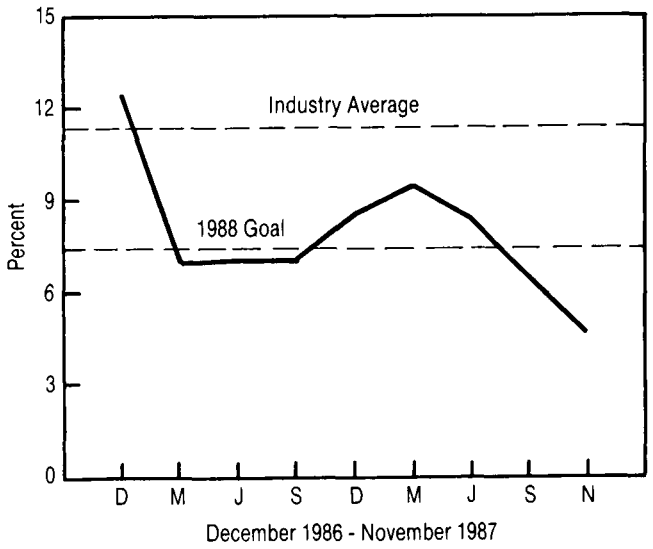

Figure 14. Scrap, rework, and repair hours as a percentage of direct labor hours (all programs)

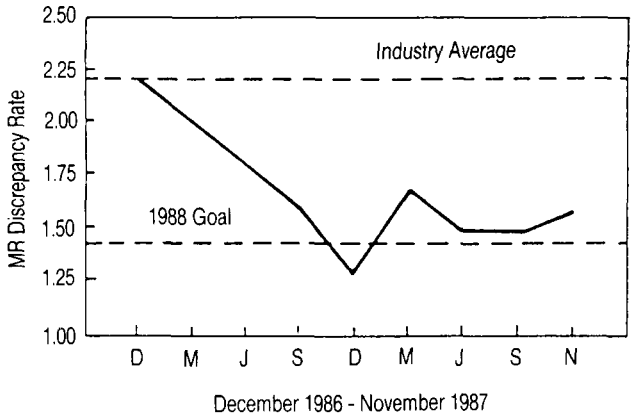

Figure 15. Material reviews per 1,000 direct labor hours (all programs)

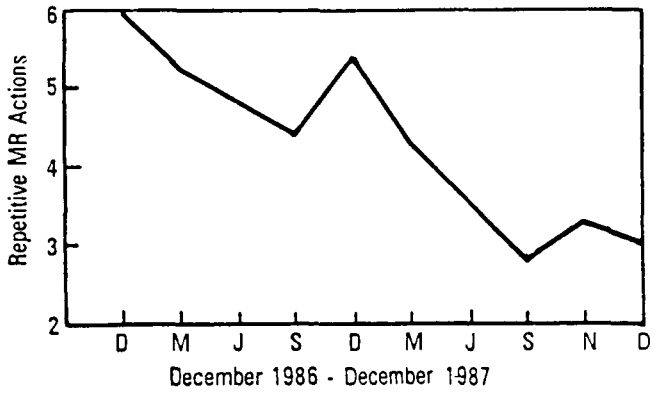

Figure 16. Repetitive material review actions per 10,000 direct labor hours (all programs)

To avoid dependence on end-of-process inspection, we have implemented effective in-process quality-control methods and technologies. We have long emphasized defect prevention and early detection in lieu of end-item acceptance. On-machine or in-process inspections are used, and only simple, low-cost parts are permitted to be completed without formal in-process inspection. A special multifunctional task team has been implementing statistical process control to predict critical process behavior. Statistical process control has been used successfully to control chemical tanks in Manufacturing. A savings of 5,720 hours per year has been realized from reducing the number of tanks out of process specification control limits. Process control charts are now maintained to provide feedback to operators regarding control limits. Our defect-reporting system identifies and reports on problems early in the process. Nonconformance information is reported back to department management for discussion with operators within one day of detection. We regularly analyze our nonconformance data base to identify trends, excessive costs, high modes, repetitive problems, etc. These data are used by corrective action boards, producibility groups, and *ad hoc* teams to develop process improvements.

Throughout the design, fabrication, and test cycle, automated processes have been developed. In the inspection area we have significantly expanded our capability the past five years through technique refinements, training, and capital expenditure for state-of-the-art measuring equipment. Our people have refined techniques, particularly in the nondestructive test area, that now permit us to discern and quantify flaws half as large as with previous methods. We have developed the capability to perform penetrant inspection in previously inaccessible areas by using remote manipulators and black-light borescopes. We have also developed innovative techniques for placing X-ray film into areas previously inaccessible to nondestructive test inspection.

We have placed into use fully automated inspection devices, including several computer-controlled coordinate measuring machines, a gear-spline-measuring machine, a laser turbine-blade-measuring machine, and several automatic optical measuring machines. We also have nearly doubled our nondestructive test inspection capability and replaced almost all of our older equipment with modern equipment. A development effort has demonstrated that we can provide inspection probe capability on the machine. Implementation now underway will permit 100 percent on-the-machine inspection of hardware. A calibration program has improved the accuracy and provided continuous visibility of the performance of our machine tools.

In 1985 we increased the stature and authority of our quality audits function to measure quality performance. We made significant advancements in the audit process, including the development of statistical sampling plans, audit ratings, computer-compatible codes for findings, causes, risks, and trend and risk analyses. These advancements increased confidence in operations.

Figure 17.
Modernized computer controlled machine tool

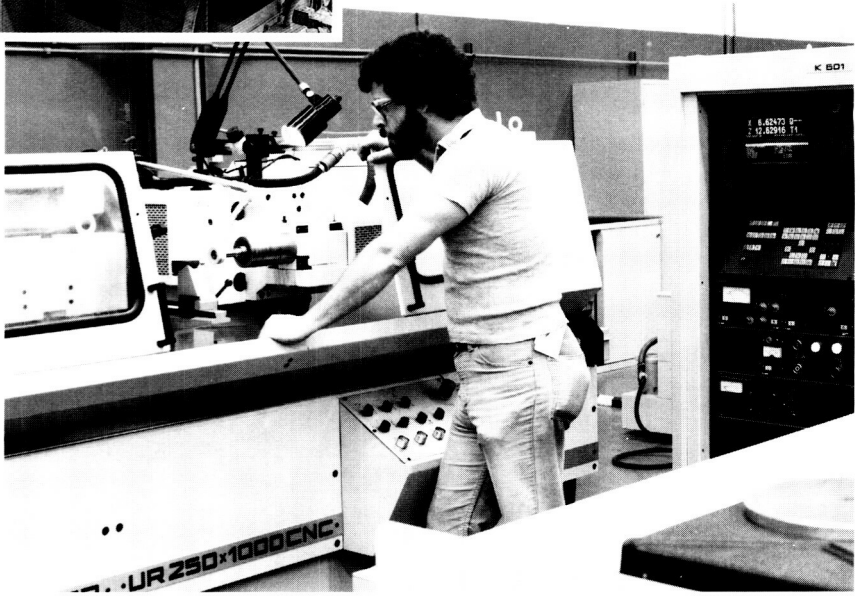

Figure 18.
Computer-controlled lathe

Figure 19.
Computer-controlled coordinate measurement machine

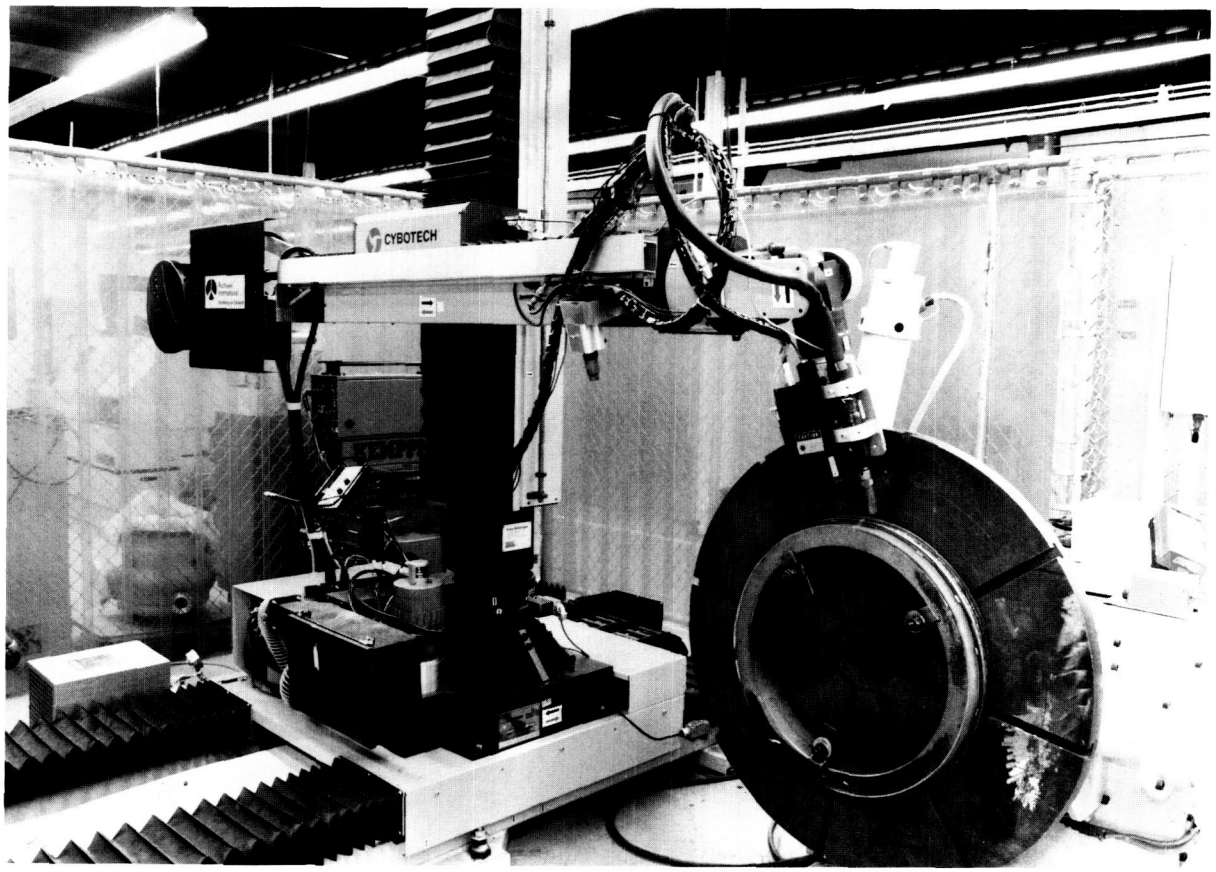

Figure 20. Robotic welder with feedback controls

Productivity Initiatives and Innovations

A $90 million facility and equipment modernization program has improved quality and productivity. The modernization program included $34 million for machinery and equipment, $21 million for land and buildings, and $35 million for production machine tools. Major improvements (Figures 17, 18, 19) were:

- SSME Turbopump Fabrication Center
- SSME Overhaul Center
- Robotic welding capability
- Machine tool modernization
- New material warehouse
- Factory layouts optimized
- Additional capacity for key operations
- Automated storage carousels with robotic extractors
- State-of-the-art inspection technology
- Automated control system for machine tool tapes

The Turbopump Fabrication Center provides for machining, welding, chemical processing, inspecting, and packaging of machined parts using computer numerically controlled machines, a dedicated staff, and engineered work station layouts.

The weld modernization program is providing a robotic welding capability (Figure 20). The eight Cybotech gas tungsten arc-welding robots so far installed have performed more than 1,250 production welds, and annual savings are running at 8,400 manufacturing hours. The robotic welds are of exceptional quality, reducing the overall weld defect rate by 50 percent. Robotic weld quality has been enhanced by a joint fabrication development project at Marshall Space Flight Center's Fabrication/Productivity Center, where nine Rocketdyne employees work as a team with the NASA technicians and engineers. They have developed many robotic weld tools now in use at Canoga Park.

Almost 2,000 operations have been converted from conventional machining to computer numerically controlled machining with reductions of 70 percent in nonconformances, and more than 7,000 hours in machining time.

Almost 2,000 operations have been converted from conventional machining to computer numerically controlled machining with reductions of 70 percent in nonconformances, and more than 7,000 hours in machining time. For example, new machine tools were used to improve quality and reduce machining flow time from eight weeks to four on

Table 5. Some specific producibility improvements

Producibility Improvement	Cost Avoidance (Thousands of Dollars)
Main Injector - Overhaul Requirement Eliminated	502
Main Combustion Chamber, Outlet Splitter and Elbow - N/C Machining Eliminated Seven Weld Joints	276
High Pressure Fuel Turbopump Cap and Tongue - N/C Machining Eliminated Four Weld Joints	186
Hot Gas Manifold - Redesigned to Reduce Weld Defects at the Mechanical Opening	142
Main Combustion Chamber Inlet Splitter Elbow - One Piece Fabrication Eliminated Six Weld Joints	135
Main Combustion Chamber Outlet Manifold - Robotic Welding Was Introduced to Minimize Weld Distortion	126
High Pressure Oxidizer Turbopump - A Freon Flush Operation Was Added to Improve Quality	88
Lines and Tube Assemblies - Overhaul Requirements Were Redefined to Reduce Scrap	75
High Pressure Fuel Turbopump Insulated Cover - Operations Were Resequenced to Complete Machining Before Foam Insulation	62
High Pressure Oxidizer Turbopump, Turbine Discharge - Strut Was Redesigned to Eliminate Copper Plating Operations	40

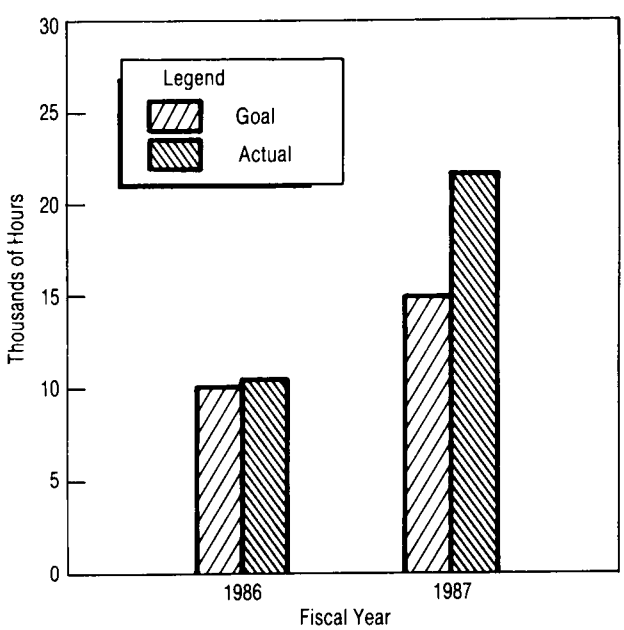

Figure 21. Factory hours saved through methods engineering

600 SSME main injector post stubs. New electrical discharge machines have reduced machining time by 66 percent, while improving the surface finish quality of machined parts by 58 percent. A pilot project for direct numeric control of production machine tools has been implemented, and cost projections show an expected savings of $30,000 per machine per year.

A vigorous producibility and methods-improvement program has resulted in a 15 percent reduction in fabrication and assembly hours for the SSME. Some of the specific producibility improvements that have contributed to cost reductions, based on a rate of six engines per year, are given in Table 5.

Our methods engineering effort was recently expanded and numerous improvements were made, including:

- Bearing packaging. An improved packaging process that has eliminated corrosion of SSME turbopump bearings and yet achieved a net savings of 92 hours per month.
- X-ray productivity. A review and streamlining of all radiographic activities that has saved 14,000 hours during fiscal year 1987.
- Gold-plating-methods improvements on turbopump discs and shafts. Projected to save 55 average flow days per part.
- RETOP (Reduce the Effective Time of Procurement). A review of the procurement system that has resulted in 13 percent more documents processed each hour and savings of $1.3 million in fiscal year 1987.
- Dock-to-Stock. A review and resulting changes that have reduced the time it takes to receive materials at the dock and have them ready for issue at the stock room, saving 2,550 hours in 1987.
- Bagging and tagging. A study that has revealed that bagging of weld samples from the clean processing area could be done in large quantities instead of individually. This eliminated the time-consuming individual identification process, saving 1,000 hours in fiscal year 1988 alone (Figure 21).

Material handling engineers have introduced procedural changes and employee awareness and certification programs to save $1.5 million through reduced in-process damage to hardware. Rocketdyne's material handling organization has been used as a model to develop a similar organization at Kennedy Space Center.

Automation and artificial intelligence have been used extensively in the areas of machinery, welding, bar coding, and test data analysis to improve quality and productivity. The computer numerically controlled programs for the most complex SSME parts (five-axis machines) are now being generated using computer-aided design/manufacturing (CAD/CAM) technology. Computer generated models are routinely used to create numerically controlled programs. These CAD/CAM models have allowed more complex parts to be programmed and are reducing the numerically controlled programming time. A direct numerically

Figure 22. Computational fluid dynamics

controlled link with the shop floor has been established, reducing the time required to proof and load programs. Bar coding is being used extensively to reduce manual data entry and improve accuracy.

Manufacturing work orders, shop employee badges, hand tools, company property, and material transfer documents are all bar coded. Bar coding of the work order alone saves $107,000 annually. Integrated, automated storage and retrieval systems have been installed using computer-controlled mechanized carousels with bar-coded labels. The work-in-process system alone is estimated to save $162,000 annually.

The Software Development Laboratory uses state-of-the-art tools to design and test the SSME Block II controller with fewer personnel than are required to support the Block I controller. We have achieved a major breakthrough in the automated testing of software. Using a custom language and special test equipment, man-rated software is quickly and thoroughly tested.

The Rocketdyne-developed Automated Dynamic Data Analysis and Management System is used to collect and analyze SSME high-frequency vibration test data. Expert systems technology is used to recognize normal situations and to highlight anomalies. This system allows a more comprehensive analysis of SSME tests to be performed and has increased productivity by reducing the processing time from 48 to 18 hours, thereby supporting our accelerated SSME testing program.

We have aggressively pursued new opportunities for optimum software use created by the growth of computer software and technology. Advances in database management systems, computer graphics, computer-aided design/analysis, and office automation have improved productivity and product quality.

The increasing use of computer-aided design and computer-aided engineering (CAD/CAE) by Rocketdyne is transforming product definition from a paper to an electronic basis. Product design has been improved through extensive computer simulations and analyses,

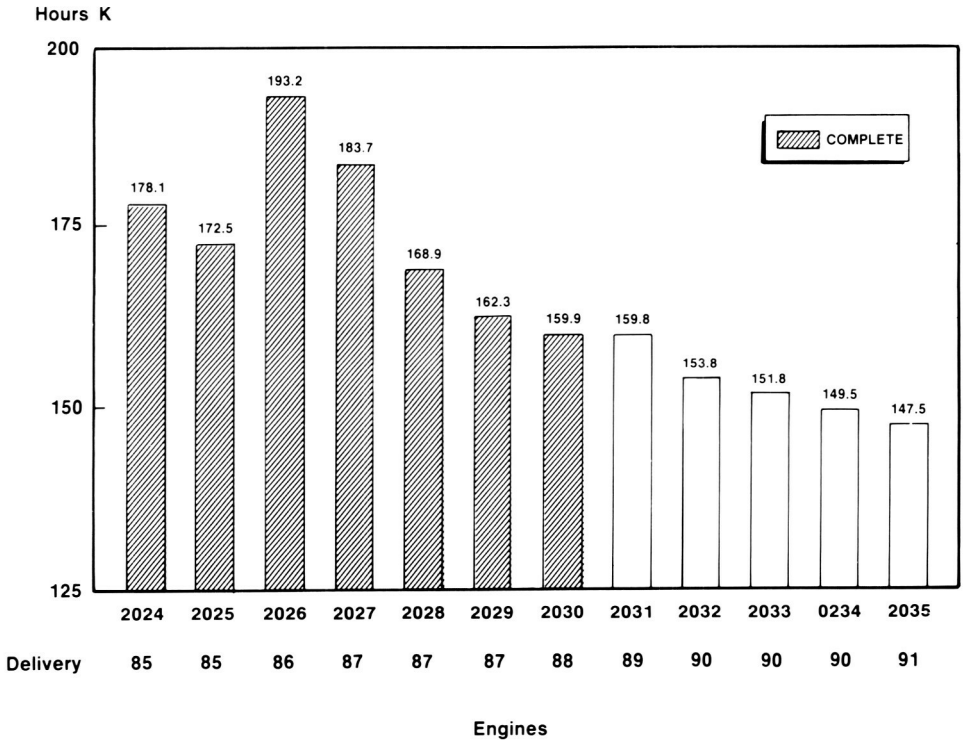

Figure 23. SSME engine fabrication hours

most notably in the area of computational fluid dynamics. Software developed by Rocketdyne is used to generate unique displays of complex 3-D fluid flow analyses on high-resolution color terminals (Figure 22). Computational fluid dynamics is now routinely used to resolve complex engineering problems, such as the analysis of the high-pressure fuel turbopump hot gas manifold and main injector thermal and flow environments. That analysis determined the optimum configuration and saved the cost of extensive testing, estimated at $720,000.

Comprehensive, integrated information systems have been developed to improve productivity and control. Certain engineering configuration documents can now be completely produced using the Automated Document Management System, including electronic sign-off and routing with Marshall Space Flight Center. The integrated Manufacturing Information System controls inventory, production requirements, procurement, and the shop floor in order to manufacture products efficiently and expeditiously. An on-line shop priority system has been developed. Labor and status information is collected on-line by 130 conveniently located shop data collection terminals.

Detailed work instructions are entered into the on-line Automated Planning System, making it possible to easily modify shop work instructions, reducing the planning backlog by 8 percent and increasing planning throughput by 18 percent. The Automated Order Release System integrates the Automated Planning System and manufacturing requirement systems to create a complete, bar-coded work order. Currently, more than 8,000 CAD-generated sketches are being incorporated in the work order to improve legibility and simplify making changes. This integrated text/graphics work order is projected to save $168,000 annually.

Subcontractors Are Part of It All

Rocketdyne has a long-standing commitment to a close team relationship with suppliers. Therefore, we involve our suppliers in all matters that could affect them and our product. Subcontractor quality continues to improve and has been stimulated by an effective supplier rating system, supplier survey program, and corrective action program.

Suppliers are chosen from those with demonstrated quality performance; only those that pass a methodical survey are entered into the approved supplier list. We conduct annual surveys to assure continued performance to required levels. In addition, Supplier Product Integrity Assessment teams have been established with members from Purchasing, Engineering, Manufacturing, Procurement, Quality Assurance, and the customer to reaffirm the capability of current suppliers that are producing critical hardware and to verify the quality of existing hardware. Guidelines and a standard assessment checklist have been developed, critical suppliers identified, and visits to suppliers' facilities prioritized. Expert technical teams have conducted 240 Supplier Product Integrity Assessments at supplier facilities. This has provided excellent information exchange, exposed real and potential problem areas, and improved the processing and fabrication of critical hardware by our suppliers (Figures 23, 24).

We have an aggressive corrective action program that requires suppliers to identify root causes and to implement effective corrective action. A Supplier Corrective Action Handbook has been sent to all suppliers, many of whom have requested copies for their suppliers. Corrective Action seminars have also been conducted for supplier personnel. The result has been a marked improvement in supplier performance. In June of 1986 a supplier Quality Improvement Committee, comprised of Quality Assurance and Material management, was established to work together to improve supplier performance. These activities have greatly enhanced the suppliers' understanding of flow-down requirements both technically and administratively.

Expert technical teams have conducted 240 Supplier Product Integrity Assessments at supplier facilities.

All of the approximately 725 suppliers who provide materials for our NASA programs received a letter communicating the goals and objectives of the PIQE system and asking them to set up a system of their own. We offered our assistance in doing this and made a starter kit available to all of them.

Information sharing with subcontractors is extensive. Our semiannual *Supplier Newsletter* provides a general outlook regarding new business opportunities, areas of concern, customer perspectives, and messages from

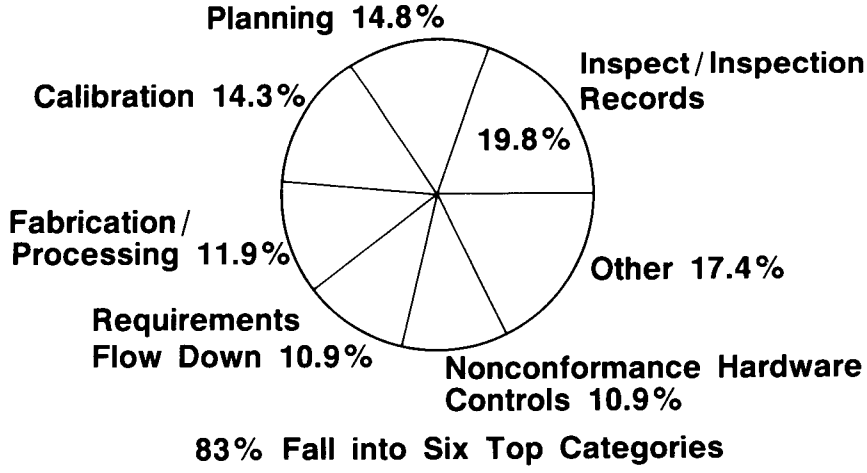

Figure 24. Supplier Product Integrity Assessments results

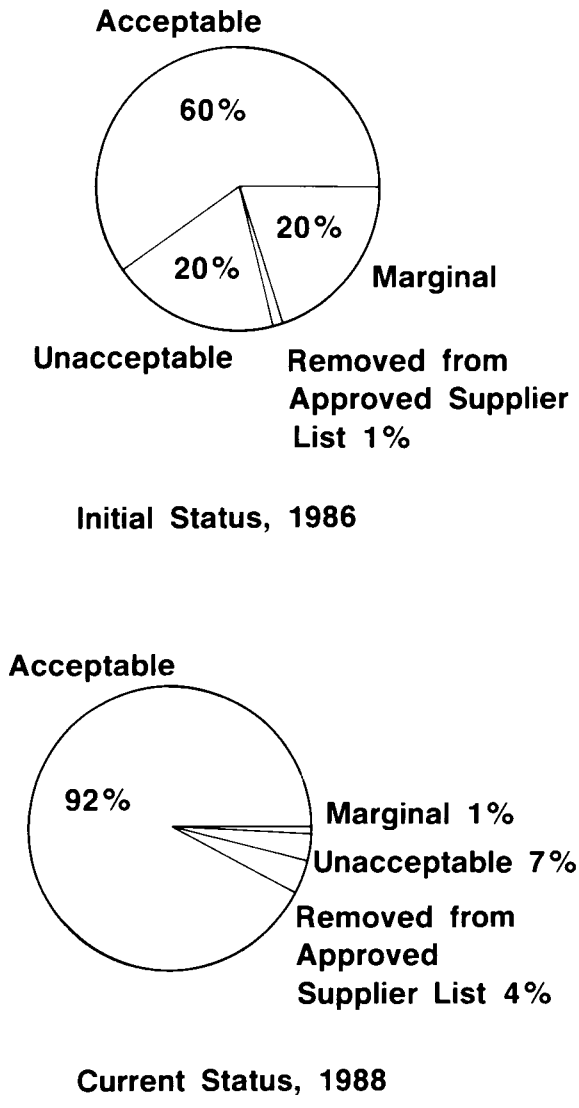

Figure 25. Improvements resulting from SPIA

Rocketdyne executive management. We communicate quarterly with each supplier regarding his quality acceptance rating, delivery performance rating, and quality cost index.

Recognition, award/reward, and other performance incentive programs are very important to Rocketdyne and our suppliers. We name a Supplier of the Quarter in five different commodity categories and recognize the winners at a luncheon hosted by our Material and Quality Assurance management. A Supplier of the Year in each commodity category is honored at a ceremony hosted by Rocketdyne's president. In addition, Rocketdyne has established the 100 Percent Club to recognize those suppliers who achieve a 100 percent rating in quality and delivery performance for an entire fiscal year.

Improvement training programs are conducted for the benefit of suppliers. We provide continuing assistance to suppliers on new and critical issues. In May of 1987 Rocketdyne hosted a conference, titled Product Quality and Business Ethics, that was attended by more than 400 suppliers and Rocketdyne personnel and featured speakers such as J. R. Thompson of Marshall Space Flight Center and Dr. Robert Rohal of Lewis Research Center. Richard Schwartz, president of Rocketdyne, and George Jeffs, president of Rockwell International's North American Space Operations, also offered valuable insights to the supplier audience. In addition, we hosted numerous supplier workshops to educate suppliers regarding specific problem areas and issues.

The cost-based supplier rating program has provided excellent means to measure cost savings effectively at the level of the supplier. Since the inception of the cost-based supplier rating system, significant improvements have been achieved in overall supplier performance. At program start-up, the average cost index for all productive material suppliers was $107.80 for every $1,000 received at Rocketdyne. These costs were related to Material Review actions, incorrect documentation packages, late deliveries, and returns to suppliers. By the end of fiscal year 1987, this cost had fallen to $38.40 per $1,000. This improvement by our suppliers resulted in a savings of approximately $2.6 million during 1987.

In Summary

The productivity increases and the quality record described above are a result of management philosophy and PIQE processes that are firmly institutionalized in Rocketdyne and integrated into our way of life. Although effective and mature, our process will remain ever changing for continuous improvement.

Our people have formed a cohesive team with NASA to ensure that the best capability in the country is applied to our demanding tasks.

STRATEGY 1

LEADERSHIP MUST COMMIT TO REVITALIZATION

Cultural change begins at the top with visible, valid commitment. Leaders must be active, persistent advocates of the need for change. At both the national and organizational levels, leadership is responsible for developing clearly defined goals and objectives to improve quality and increase productivity while creating an environment that enables change to take place. This includes reeducating the middle manager and fostering teamwork at all levels.

The leaders of Rocketdyne, the 1987 recipient of this award, have made the strongest of commitments to continuing revitalization, not only through statements but through visible actions both within and without the organization. The CEO of Rockwell International established a policy in 1976, set priorities, and took the lead in several national efforts on quality and productivity. More recently he has called for commitment from all top management to a Rockwell credo for revitalization. Rocketdyne president Richard Schwartz fostered a series of strong initiatives starting with a Commitment to Excellence in January of 1984, a Quality Enhancement Plan, a Product Integrity Council, an organized structure to productivity, PIQE teams, an executive producibility plan, and many communication and motivation actions. Formalization of top management goals as part of the strategic business plan, dissemination of these goals throughout the organization, and the tracking of progress all serve to maintain visibility and focus on continuous improvement.

The commitment of $70 million of capital to factory modernization as well as $20 million for continual upgrading of computer integration have given substance to the policy. A clear message from *Challenger* was the importance of sticking to announced principles under pressure. Rocketdyne has shown clear evidence of doing just that—an indication of the strength of their commitment to quality.

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STRATEGY 2

MAKE QUALITY INTEGRAL TO ORGANIZATION CULTURE

A top-quality mentality is a requisite for organizational and product survival. It is an attitude that must be ingrained as a way of life for an organization—part of a philosophy that says: "When I pass my work on to the next person, it will be the best that I can do." It is the essential ingredient in a management culture that refuses to condone waste and is constantly looking for ways to make improvements. From the customer's perspective, it is the expectation of quality, the refusal to accept anything but the best. Quality performance should be recognized and rewarded by the organization.

Rocketdyne has a special commitment to quality which comes from a keen awareness that the product has to work right the first time and every time. Over the past four years there has been a dynamic rededication to quality and quality improvement through managerial leadership, personal accountability, and a commitment to excellence.

This focused team-wide dedication has resulted in significant improvements and exceptional levels of performance in all facets of Rocketdyne operations.

Rocketdyne people, organizations, and management commonly set tough performance goals for themselves and then beat those goals. Rocketdyne's president establishes agreed-upon quality performance goals with his customers and tracks progress through a joint customer/Rocketdyne Product Integrity Council. Vice presidents, in turn, establish goals with the company president, and progress is reviewed in monthly Operations Review meetings. In Rocketdyne's departmental Challenge of Excellence program (which measures seven prime work categories, including quality), goals are constantly met or exceeded. Monthly and quarterly winners—those showing the most improvement—are recognized by top management and rewarded through gift certificates and plaques.

Multifunctional teams frequently attack difficult quality issues with extraordinary results. For instance, an IV-C Penetrant PIQE team is currently working on reducing nonconformances resulting from IV-C Penetrant (a super-discriminating penetrant) of welds; the results of their efforts have already reduced nonconformance by 60 percent.

This pervasive drive for quality excellence has resulted in outstanding product performance. In the past six years, Rocketdyne's engines have been successful 99.4 percent of the time, with zero mission failure attributable to Rocketdyne's product performance.

STRATEGY 3

FOCUS ON THE CUSTOMER

World class competitive organizations know their customers and are able to apply management techniques and organizational skills to provide what their customers want. They recognize that quality is what the customer needs. They work with their customers as partners throughout the product design, development, and delivery process. Focusing on both internal and external customers is an essential ingredient to an organization's future success.

Essential to understanding customer needs are strong communication channels and programs. Rocketdyne has established regularly scheduled daily, weekly, monthly, and quarterly teleconferences and meetings between Rocketdyne and Marshall Space Flight Center personnel. This establishes NASA/Rocketdyne teamwork throughout design, development, certification, ground-test, and flight operations. It is imperative that both the customer and contractor thoroughly understand both the strengths and weaknesses of the program.

Timely responsiveness to program weaknesses is a key ingredient to customer satisfaction. The Space Shuttle Main Engine margin improvement and aggressive ground-test programs are examples of responding to customer needs. Not only did Rocketdyne meet the customers' expectations, but exceeded them in certain areas. In response to Marshall Space Flight Center's request for an aggressive ground-test program, Rocketdyne conducted the equivalent of 58 Space Shuttle missions since *Challenger*, certified 21 hardware changes, performed 60 limits/margin tests and achieved the longest duration ground test of a large liquid-rocket engine in the history of the United States—2,017 seconds, or 33.6 minutes.

STRATEGY 4

ACCEPT AND MANAGE CHANGE

Basic to improvement is the ability to change and adjust to competition and to customer demands. Maintaining an entrepreneurial spirit and an openness to new technology and ideas requires management's ability to accept and manage risk. This is essential to fostering innovation and to carrying the fruits of innovation to a successful conclusion in the form of marketable products and quality services. Successful organizations are able to accept risk and manage change as a part of growth, understanding that focusing on long-range goals and having a vision for the future is more important than a preoccupation with the short-term "bottom line."

Rocketdyne places high value on innovation, developing new technology, and finding new applications for these developments. Advancements for the solar dynamic power system and National Aero-Space Plane propulsion, as well as laser system, are prime examples of recognizing both the need for and the value of change. Top management encourages change in order to make advancements in technology and product lines. Difficult challenges have been willingly accepted in this development phase. The process of rocket-engine design demands a careful balance between the tight, even rigid, discipline of design, fabrication, testing, and operation, and the challenging of the status quo in technology development and problem solving. Rocketdyne management fully understands the elements involved in managing the endless variety of risk in space propulsion and power advancement.

STRATEGY 5

ESTABLISH A PROCESS TO INVOLVE AND RECOGNIZE EMPLOYEES

Good communications throughout an organization are essential to the revitalization process and help instill a sense of shared destiny in the work force. Employee motivation is the critical task associated with improving quality and productivity. Good communications and trust are essential to marshalling employee talents and capabilities to solve problems and allow continuous improvement to become an organizational way of life. Participative management should be encouraged in the organization and supported by ongoing management/employee training programs. It is particularly important that new programs are not perceived as undermining employee jobs or positions. Employee teams and suggestion programs, tailored to an organizational culture, stimulate involvement; they allow issues to be addressed by those who are closest to the problem.

Rocketdyne has found that motivation and employee involvement in decision-making is a process that needs to be cultivated over a period of time. It cannot be imposed. The company culture must be improved, instilling a sense of ownership and pride in workmanship. Rockwell's company credo is aimed at increasing each employee's awareness of the importance of individuals in the success of the corporation. Rocketdyne's commitment to customer and employee satisfaction is embodied in this sense of involvement by everyone in the organization.

Communication plays an important role in this transformation. New ways of operating and involving people provide the knowledge out of which teamwork can flourish.

Various methods are used to encourage employee identification with company goals: reward systems, suggestion systems, and appreciation programs that provide both tangible and intangible rewards. Cultural change is tied to many integrated broad-based initiatives which are constantly changing. What was effective for the work force of 1987 might not be the best system or program for future generations of employees. The task is to seek, probe, and constantly analyze opportunities in organizational change.

STRATEGY 6

MEASURE ACTIVITIES TO EVALUATE SUCCESS

Achieving a top-quality culture within an organization requires continual, measurable improvements. Measurement is far more than keeping score. It is necessary for good communications and for focusing attention on priorities and on areas needing improvement. It provides for reinforcement of progress toward goals and ensures and establishes accountability and an evaluation of "how well one is doing." Measures are most successful when employees are involved in determining what the measures should be and how to achieve them—employee ownership is essential.

Rocketdyne has a system of 44 trend charts which are published quarterly for top management to watch "the health of Rocketdyne" and which show performance by the month against goals and/or industry averages. When data deviates from a goal, a corrective plan is issued. Hundreds of similar trend charts are used by program and functional managers to flag problems and assess effectiveness of solutions. In shop groups, first-line managers have "challenge of excellence" displays showing the group's performance in the belief that it is absolutely necessary that employees know immediately if their work is satisfactory. Trend measurements provide this along with baselines for judging.

STRATEGY 7

EMPHASIZE EDUCATION AS A KEY TO THE FUTURE

A quality ethic and a highly productive society depend on an educated work force. In order to be competitive, organizations must be able to employ qualified people and then "involve" them, in order to maximize their contributions and establish a basis for developing high-quality products and services. Thus, in the broader context, America must produce a talented, educated work force, with the awareness and understanding necessary to function effectively and productively. Business must let the educational establishment know what it needs, and be willing to work closely with schools and universities to achieve it. Business and government leaders must support the upgrading of the nation's educational system.

Rocketdyne realizes the importance of ongoing learning and has supported the educational development of its employees since its organization more than 30 years ago. All managers and employees are encouraged to upgrade their formal education through a policy of 100 percent reimbursement of tuition costs and other college-related expenses. There has been a 75 percent increase in educational program expenditures since 1983. Increasing numbers of employees are taking courses in artificial intelligence, computer science, business management, and other university programs to enhance their own skills and provide the company with long-term technological capabilities.

There are several on-site university programs that conveniently allow employees to continue their educational progress. Certificate programs represent a fairly new approach to technical development. Increasing numbers of employees specialize in program management, computer science, and management skills.

The company credo, along with progress toward a customer- and employee-based organization culture, requires a commitment to employee growth. Even through these times of high costs of formal education, Rocketdyne remains firm in this commitment to educational excellence. Every employee has the opportunity to seek job-related education and training programs that meet personal and organizational needs. Rocketdyne realizes the importance of working with local universities to recommend and design certain courses of study. This educational alliance is a large, positive step in promoting the best possible education to meet industry needs.

Award Finalists' Recognition

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